

$\Delta(1910) 1/2^+$

$$I(J^P) = \frac{3}{2}(\frac{1}{2}^+) \text{ Status: } ****$$

Most of the results published before 1975 were last included in our 1982 edition, Physics Letters **111B** 1 (1982). Some further obsolete results published before 1984 were last included in our 2006 edition, Journal of Physics, G **33** 1 (2006).

NODE=B012

NODE=B012

$\Delta(1910)$ BREIT-WIGNER MASS

NODE=B012M

NODE=B012M

→ UNCHECKED ←

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1860 to 1910 (\approx 1890) OUR ESTIMATE			
1860 \pm 40	ANISOVICH	12A	DPWA Multichannel
2067.9 \pm 1.7	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1910 \pm 40	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
1888 \pm 20	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1934 \pm 5	SHRESTHA	12A	DPWA Multichannel
1995 \pm 12	VRANA	00	DPWA Multichannel
2152	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1882 \pm 10	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$
1960.1 \pm 21.0	¹ CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
2121.4 $^{+13.0}_{-14.3}$	¹ CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
1790	² LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$

OCCUR=3

OCCUR=4

$\Delta(1910)$ BREIT-WIGNER WIDTH

NODE=B012W

NODE=B012W

→ UNCHECKED ←

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
220 to 340 (\approx 280) OUR ESTIMATE			
350 \pm 55	ANISOVICH	12A	DPWA Multichannel
543 \pm 10	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
225 \pm 50	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
280 \pm 50	HOEHLER	79	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
211 \pm 11	SHRESTHA	12A	DPWA Multichannel
713 \pm 465	VRANA	00	DPWA Multichannel
760	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
239 \pm 25	MANLEY	92	IPWA $\pi N \rightarrow \pi N \& N\pi\pi$
152.9 \pm 60.0	¹ CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
172.2 \pm 37.0	¹ CHEW	80	BPWA $\pi^+ p \rightarrow \pi^+ p$
170	² LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$

OCCUR=3

OCCUR=4

$\Delta(1910)$ POLE POSITION

NODE=B012215

REAL PART

NODE=B012RE

NODE=B012RE

→ UNCHECKED ←

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
1830 to 1880 (\approx 1855) OUR ESTIMATE			
1850 \pm 40	ANISOVICH	12A	DPWA Multichannel
1771	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
1874	³ HOEHLER	93	SPED $\pi N \rightarrow \pi N$
1880 \pm 30	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
1910	SHRESTHA	12A	DPWA Multichannel
1880	VRANA	00	DPWA Multichannel
1810	ARNDT	95	DPWA $\pi N \rightarrow N\pi$
1950	ARNDT	91	DPWA $\pi N \rightarrow \pi N$ Soln SM90
1792 or 1801	² LONGACRE	77	IPWA $\pi N \rightarrow N\pi\pi$

-2xIMAGINARY PART

NODE=B012IM

NODE=B012IM

→ UNCHECKED ←

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
200 to 500 (\approx 350) OUR ESTIMATE			
350 \pm 45	ANISOVICH	12A	DPWA Multichannel
479	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
283	³ HOEHLER	93	SPED $\pi N \rightarrow \pi N$
200 \pm 40	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

• • • We do not use the following data for averages, fits, limits, etc. • • •

199	SHRESTHA	12A	DPWA	Multichannel
496	VRANA	00	DPWA	Multichannel
494	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
398	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90
172 or 165	² LONGACRE	77	IPWA	$\pi N \rightarrow N\pi\pi$

$\Delta(1910)$ ELASTIC POLE RESIDUE

NODE=B012220

MODULUS $|r|$

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
24 ± 6	ANISOVICH	12A	DPWA Multichannel
45	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
38	HOEHLER	93	SPED $\pi N \rightarrow \pi N$
20 ± 4	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

NODE=B012RER
NODE=B012RER

• • • We do not use the following data for averages, fits, limits, etc. • • •

53	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
37	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

PHASE θ

VALUE (°)	DOCUMENT ID	TECN	COMMENT
-145 ± 30	ANISOVICH	12A	DPWA Multichannel
+172	ARNDT	06	DPWA $\pi N \rightarrow \pi N, \eta N$
-90 ± 30	CUTKOSKY	80	IPWA $\pi N \rightarrow \pi N$

NODE=B012IMR
NODE=B012IMR

• • • We do not use the following data for averages, fits, limits, etc. • • •

-176	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
-91	ARNDT	91	DPWA	$\pi N \rightarrow \pi N$ Soln SM90

$\Delta(1910)$ INELASTIC POLE RESIDUE

NODE=B012240

The "normalized residue" is the residue divided by $\Gamma_{pole}/2$.

NODE=B012240

Normalized residue in $N\pi \rightarrow \Delta(1910) \Rightarrow \Sigma K$

MODULUS (%)	PHASE (°)	DOCUMENT ID	TECN	COMMENT
7 ± 2	-110 ± 30	ANISOVICH	12A	DPWA Multichannel

NODE=B012RS1
NODE=B012RS1

Normalized residue in $N\pi \rightarrow \Delta(1910) \Rightarrow \Delta\pi, P$ -wave

MODULUS (%)	PHASE (°)	DOCUMENT ID	TECN	COMMENT
16 ± 9	95 ± 40	ANISOVICH	12A	DPWA Multichannel

NODE=B012RS2
NODE=B012RS2

$\Delta(1910)$ DECAY MODES

NODE=B012225;NODE=B012

The following branching fractions are our estimates, not fits or averages.

NODE=B012

Mode	Fraction (Γ_i/Γ)
Γ_1 $N\pi$	15-30 %
Γ_2 ΣK	(9 ± 5) %
Γ_3 $N\pi\pi$	
Γ_4 $\Delta\pi$	(60 ± 28) %
Γ_5 $\Delta(1232)\pi, P$ -wave	
Γ_6 $N\rho$	
Γ_7 $N\rho, S=3/2, P$ -wave	
Γ_8 $N(1440)\pi$	
Γ_9 $N(1440)\pi, P$ -wave	
Γ_{10} $N\gamma$	0.0-0.02 %
Γ_{11} $N\gamma, \text{helicity}=1/2$	0.0-0.02 %

DESIG=1;OUR EST

DESIG=2

DESIG=3

DESIG=181

DESIG=4

DESIG=182

DESIG=5

DESIG=6

DESIG=62

DESIG=183;OUR EST

DESIG=7;OUR EST

$\Delta(1910)$ BRANCHING RATIOS

NODE=B012230

 $\Gamma(N\pi)/\Gamma_{\text{total}}$ **Γ_1/Γ**

VALUE (%)

DOCUMENT ID TECN COMMENT

15 to 30 OUR ESTIMATE

12 \pm 3	ANISOVICH	12A	DPWA	Multichannel
23.9 \pm 0.1	ARNDT	06	DPWA	$\pi N \rightarrow \pi N, \eta N$
19 \pm 3	CUTKOSKY	80	IPWA	$\pi N \rightarrow \pi N$
24 \pm 6	HOEHLER	79	IPWA	$\pi N \rightarrow \pi N$

• • • We do not use the following data for averages, fits, limits, etc. • • •

17 \pm 1	SHRESTHA	12A	DPWA	Multichannel
29 \pm 21	VRANA	00	DPWA	Multichannel
26	ARNDT	95	DPWA	$\pi N \rightarrow N\pi$
23 \pm 8	MANLEY	92	IPWA	$\pi N \rightarrow \pi N \& N\pi\pi$
17	¹ CHEW	80	BPWA	$\pi^+ p \rightarrow \pi^+ p$
40	¹ CHEW	80	BPWA	$\pi^+ p \rightarrow \pi^+ p$

NODE=B012R1
NODE=B012R1
→ UNCHECKED ←OCCUR=3
OCCUR=4 **$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1910) \rightarrow \Sigma K$** **$(\Gamma_1\Gamma_2)^{1/2}/\Gamma$**

VALUE

DOCUMENT ID TECN COMMENT

< 0.03 CANDLEIN 84 DPWA $\pi^+ p \rightarrow \Sigma^+ K^+$

• • • We do not use the following data for averages, fits, limits, etc. • • •

-0.019 LIVANOS 80 DPWA $\pi p \rightarrow \Sigma K$ NODE=B012R2
NODE=B012R2 **$\Gamma(\Sigma K)/\Gamma_{\text{total}}$** **$\Gamma_2/\Gamma$**

VALUE (%)

DOCUMENT ID TECN COMMENT

9 \pm 5 ANISOVICH 12A DPWA MultichannelNODE=B012R01
NODE=B012R01

Note: Signs of couplings from $\pi N \rightarrow N\pi\pi$ analyses were changed in the 1986 edition to agree with the baryon-first convention; the overall phase ambiguity is resolved by choosing a negative sign for the $\Delta(1620) S_{31}$ coupling to $\Delta(1232)\pi$.

NODE=B012310

 $(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1910) \rightarrow \Delta(1232)\pi, P\text{-wave}$ **$(\Gamma_1\Gamma_5)^{1/2}/\Gamma$**

VALUE

DOCUMENT ID TECN COMMENT

+0.06 ² LONGACRE 77 IPWA $\pi N \rightarrow N\pi\pi$ NODE=B012R3
NODE=B012R3 **$\Gamma(\Delta\pi)/\Gamma_{\text{total}}$** **$\Gamma_4/\Gamma$**

VALUE (%)

DOCUMENT ID TECN COMMENT

60 \pm 28 ANISOVICH 12A DPWA MultichannelNODE=B012R02
NODE=B012R02 **$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1910) \rightarrow N\rho, S=3/2, P\text{-wave}$** **$(\Gamma_1\Gamma_7)^{1/2}/\Gamma$**

VALUE

DOCUMENT ID TECN COMMENT

+0.29 ² LONGACRE 77 IPWA $\pi N \rightarrow N\pi\pi$ NODE=B012R4
NODE=B012R4 **$(\Gamma_i\Gamma_f)^{1/2}/\Gamma_{\text{total}}$ in $N\pi \rightarrow \Delta(1910) \rightarrow N(1440)\pi, P\text{-wave}$** **$(\Gamma_1\Gamma_9)^{1/2}/\Gamma$**

VALUE

DOCUMENT ID TECN COMMENT

• • • We do not use the following data for averages, fits, limits, etc. • • •

-0.39 \pm 0.04 MANLEY 92 IPWA $\pi N \rightarrow \pi N \& N\pi\pi$ NODE=B012R5
NODE=B012R5 **$\Gamma(N(1440)\pi)/\Gamma_{\text{total}}$** **$\Gamma_8/\Gamma$**

VALUE (%)

DOCUMENT ID TECN COMMENT

56 \pm 7 VRANA 00 DPWA Multichannel

• • • We do not use the following data for averages, fits, limits, etc. • • •

47 \pm 6 SHRESTHA 12A DPWA MultichannelNODE=B012R6
NODE=B012R6

$\Delta(1910)$ PHOTON DECAY AMPLITUDES

Papers on γN amplitudes predating 1981 may be found in our 2006 edition, Journal of Physics, G **33** 1 (2006).

NODE=B012235

NODE=B012235

 $\Delta(1910) \rightarrow N\gamma$, helicity-1/2 amplitude $A_{1/2}$ NODE=B012A1
NODE=B012A1

→ UNCHECKED ←

VALUE (GeV ^{-1/2})	DOCUMENT ID	TECN	COMMENT
+0.003±0.014 OUR ESTIMATE			
0.022±0.009	ANISOVICH	12A	DPWA Multichannel
-0.002±0.008	ARNDT	96	IPWA $\gamma N \rightarrow \pi N$
0.014±0.030	CRAWFORD	83	IPWA $\gamma N \rightarrow \pi N$
0.025±0.011	AWAJI	81	DPWA $\gamma N \rightarrow \pi N$
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
0.030±0.002	SHRESTHA	12A	DPWA Multichannel
0.032±0.003	LI	93	IPWA $\gamma N \rightarrow \pi N$

 $\Delta(1910)$ FOOTNOTES

- ¹ CHEW 80 reports four resonances in the P_{31} wave — see also the $\Delta(1750)$. Problems with this analysis are discussed in section 2.1.11 of HOEHLER 83.
- ² LONGACRE 77 pole positions are from a search for poles in the unitarized T-matrix; the first (second) value uses, in addition to $\pi N \rightarrow N\pi\pi$ data, elastic amplitudes from a Saclay (CERN) partial-wave analysis. The other LONGACRE 77 values are from eyeball fits with Breit-Wigner circles to the T-matrix amplitudes.
- ³ See HOEHLER 93 for a detailed discussion of the evidence for and the pole parameters of N and Δ resonances as determined from Argand diagrams of πN elastic partial-wave amplitudes and from plots of the speeds with which the amplitudes traverse the diagrams.

NODE=B012

NODE=B012;LINKAGE=C

NODE=B012;LINKAGE=L7

NODE=B010;LINKAGE=H9

 $\Delta(1910)$ REFERENCES

NODE=B012

For early references, see Physics Letters **111B** 1 (1982).

NODE=B012

ANISOVICH	12A	EPJ A48 15	A.V. Anisovich <i>et al.</i>	(BONN, PNPI)	REFID=54041
SHRESTHA	12A	PR C86 055203	M. Shrestha, D.M. Manley	(KSU)	REFID=54862
ARNDT	06	PR C74 045205	R.A. Arndt <i>et al.</i>	(GWU)	REFID=51535
PDG	06	JPG 33 1	W.-M. Yao <i>et al.</i>	(PDG Collab.)	REFID=51004
VRANA	00	PRPL 328 181	T.P. Vrana, S.A. Dytman, T.-S.H. Lee	(PITT+)	REFID=47593
ARNDT	96	PR C53 430	R.A. Arndt, I.I. Strakovsky, R.L. Workman	(VPI)	REFID=44675
ARNDT	95	PR C52 2120	R.A. Arndt <i>et al.</i>	(VPI, BRGO)	REFID=44535
HOEHLER	93	πN Newsletter 9 1	G. Hohler	(KARL)	REFID=43821
LI	93	PR C47 2759	Z.J. Li <i>et al.</i>	(VPI)	REFID=43327
MANLEY	92	PR D45 4002	D.M. Manley, E.M. Saleski	(KSA) IJP	REFID=41535
Also		PR D30 904	D.M. Manley <i>et al.</i>	(VPI)	REFID=30071
ARNDT	91	PR D43 2131	R.A. Arndt <i>et al.</i>	(VPI, TELE) IJP	REFID=41467
CANDLIN	84	NP B238 477	D.J. Candlin <i>et al.</i>	(EDIN, RAL, LOWC)	REFID=40339
CRAWFORD	83	NP B211 1	R.L. Crawford, W.T. Morton	(GLAS)	REFID=30070
HOEHLER	83	Landolt-Boernstein 1/9B2	G. Hohler	(KARLT)	REFID=31158
PDG	82	PL 111B 1	M. Roos <i>et al.</i>	(HELS, CIT, CERN)	REFID=41167
AWAJI	81	Bonn Conf. 352	N. Awaji, R. Kajikawa	(NAGO)	REFID=30067
Also		NP B197 365	K. Fujii <i>et al.</i>	(NAGO)	REFID=30068
CHEW	80	Toronto Conf. 123	D.M. Chew	(LBL) IJP	REFID=31151
CUTKOSKY	80	Toronto Conf. 19	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP	REFID=30064
Also		PR D20 2839	R.E. Cutkosky <i>et al.</i>	(CMU, LBL) IJP	REFID=40096
LIVANOS	80	Toronto Conf. 35	P. Livanos <i>et al.</i>	(SACL) IJP	REFID=30402
HOEHLER	79	PDAT 12-1	G. Hohler <i>et al.</i>	(KARLT) IJP	REFID=30058
Also		Toronto Conf. 3	R. Koch	(KARLT) IJP	REFID=30859
LONGACRE	77	NP B122 493	R.S. Longacre, J. Dolbeau	(SACL) IJP	REFID=30051
Also		NP B108 365	J. Dolbeau <i>et al.</i>	(SACL) IJP	REFID=30052